Issues in Economics and Business
ISSN 2377-2301
2017, Vol. 3, No. 1

Emperical Review on the Relationship between Real Wages, Inflation and Labour Productivity in Nigeria. ARDL bounds testing approach

Eugene Iheanacho

Department of Economics

Abia State University Uturu, Nigeria

E-mail: eugene.iheanacho2016@yahoo.com

Received: October 3, 2016 Accepted: December 26, 2016 Published: June 23, 2017

doi:10.5296/ieb.v3i1.10497 URL: http://dx.doi.org/10.5296/ieb.v3i1.10497

Abstract

This paper examines the long run and short run relationships between real wage, inflation and labour productivity in Nigeria over the period of 1981-2012, using the autoregressive distributed lag approach (ARDL) bound testing and error correction approach to cointegration analysis. Three equations are derived from production function in form of linear equations. The result show that the variables under consideration are not statistically significant in exerting influence on productivity when treated in isolation. However, the result improved with the inclusion of control variables in the likes of real gdp per capital and government expenditure. Indeed, the results provide evidence of a positive statistical relationship between real wages and productivity growth. A positive and significant long run relationship between real wage and labour productivity coexists with a positive short run relationship thereby highlighting the dual effects of real wage on labour productivity in Nigeria. Inflation rate provides a positive and significant relationship with labour productivity contrary to related studies. The findings of this study have important implication for policy makers in Nigeria and indeed contributes to the idea that the causes of inflation in Nigeria are multi-dimensional and dynamic, requiring full knowledge at any point in time to be able to proffer solutions to the inflationary trends in that leads to high productivity and increased living standard.

Keywords: Real Wage, Inflation, Labour Productivity, Real GDP per Capita, Government Expenditure, ARDL, Nigeria

1. Introduction

Economist in the likes of Bardsen, Hurn, and Mchugh (2007) and Tsionas (2003), Kumar, Webber and Perry (2009) hypothesize that there are a number of reasons why associations may exist between real wages, inflation and productivity. Most of them argue that inflation and productivity are negatively related, usually because of the eroding effects of inflation on workers purchasing power, which affects motivation to work. Inflation is also known to affect the investment decisions of firms since firms need to anticipate and incorporate into their budgets the effects of inflation on their businesses. Bardsen et al. (2007) cite an example of how inflation also influences capital depreciation rates and choices of labour-capital production techniques.

Recent studies reveal that there is a negative relationship between inflation and productivity and concludes that an increase in inflation invariably leads to a decrease in productivity. Notable works of economists and researchers who posit a negative relationship between inflation and productivity are Clark (1982), Ram (1984), Buck and Fitzroy (1988), Saunders and Biswas (1990), Selody (1990) and Sbordone and Kuttner (1994). In contrast to these economists, some researchers such as Tsionas (2003) posit a positive relationship between inflation and productivity although empirical work on this theory has been largely confirned to a limited number of countries.

Another point of interest is the relationship between real wages and productivity, economists such as Wakeford (2004) conceive a positive relationship. Wakeford (2004) puts forward two main arguments in favour of this phenomenon the first of which is the efficiency-wage hypothesis which demonstrates how higher real wages increase the opportunity cost of job loss thereby stimulating greater work effort to avoid redundancy. The second argument concerns the marginal productivity of labour where increases in real wages result in increases in the unit cost of labour causing firms to substitute capital for labour who instinctively increase their output (marginal productivity) so as not to be laid off. The substitution of labour for capital, in response to increases in real wages, has been at the heart of business practices for centuries as stated by Gordon (1987).

Most studies on inflation and productivity focus on developed countries which have faced stagflation (periods of high inflation rates and low economic growth rates) usually in the late 1970s and early 1980s. After this period most of these countries experienced significant growth in productivity and very little inflationary. However, Nigeria is not exception to this occurrence.

The objective of this paper therefore, is to test empirically the degree of relationship between the selected macroeconomic variables similar to the work of Kumar et al. (2009). Understanding the relationship between real wage, inflation and labour productivity could have a significant impact on policy formulation of macroeconomic policies targeting efficiency in the market. Controlling for the influence of real GDP per capita and government expenditure this study therefore test and analyze any cointegration relationships that may exist between inflation, real wages and productivity in the Nigeria using the autoregressive distributed lag (ARDL) bound testing approach. By examining the relationship between these macroeconomic variables, this study contributes to a number of studies that have explore the relationship between real wage, inflation and productivity in the advance world (see Selody (1982), Clark (1982) and Hondroyiannis and Papapetrou (1997) , Christopoulos and Tsionas (2005, Ram (1984), Buck and Fitzroy (1988), Saunders and Biswas (1990), Narayan and Smyth (2009). The result of this study could be a guide to researchers and policymakers in Nigeria and other developing countries seeking to understand the long run and short run relationships and macroeconomic indicators in Nigeria.

The remainder of this paper has the following structure. Section 2 details the literature upon which my study bases its tests. Section 3 contains details of the data and methodology employed in my tests. Section 4 contains the presentation of my results. Section 5 offers an analysis of the results presented in the previous section and Section 6 concludes this paper.

2. Literature Review

In recent decades, economic literature has amongst other things, concerned itself with the research and study of the relationships between inflation, real wages and productivity growth. The effects of these variables on productivity are well-documented in the theoretical literature with considerable research using a variety of different empirical tests conducted amongst a diverse range of economies. The literature reveals that there exists broad consensus with respect to the existence of strong interrelationships among real wages, productivity and inflation. However, there has been little empirical research that tests this general agreement in the context of African market economies. This literature intends to provide the reader with a brief overview of notable works carried out in this field.

2.1 Evidence of Relationship between Inflation and Productivity

In recent decades, researchers have conducted tests that have led them to conclude the existence of a negative relationship between inflation and productivity growth. The works of Selody (1982), Clark (1982) and Hondroyiannis and Papapetrou (1997) are prominent in this area. Christopoulos and Tsionas (2005) find evidence that suggests that inflation influences the level of productivity growth by reducing the incentive and morale of labour to work, distorts the informational content contained within relative prices (which leads to inefficient investment plans), and finally shrinks the tax reductions for depreciation (which results in an increase in the rental price of capital). Other researchers such as Narayan and Smyth (2009) infer other mechanisms through which inflation adversely affects labour productivity. These include the adoption of an inefficient combination of factor inputs, an increase in buffer or reserve stocks and a reduction in Research and Development expenditures. In addition, Bulman and Simon (2003) examine the effect of inflation on productivity growth in Australia and note that broad nation-wide historical correlations infer a negative relationship between inflation and aggregate productivity growth. They also discover evidence to support the notion that the negative effects of inflation not only affect productivity by reducing capital accumulation but also by diminishing multifactor productivity growth. This last discovery of diminishing multifactor productivity, according to Bulman and Simon (2003), seems to agree with the findings of Narayan and Smyth (2009) who also conclude that inflation leads to the adoption of an inefficient combination of factor outputs. The similarities in their results are quite similar. To conduct more rigorous empirical research work, Bulman and Simon (2003), like Kumar, Webber and Perry (2009), use annual industry level data since different industries may offer varying degrees of inflation effects on productivity growth. Based on 36 annual observations for different Australian industries, Bulman and Simon (2003) attribute a part of the slowdown in Australian productivity of the 1970s and its acceleration in the 1990s to the corresponding rise and fall of inflation during these periods. However, they acknowledge that other factors other than inflation also played a part in this slowdown in productivity.

Prior to the work of Bulman and Simon (2003), Bitros and Panas (2001) examined the effects of inflationary pressures on total factor productivity amongst Greek manufacturing industries over the period 1964 and 1980 and found that inflation growth had a significant adverse effect on total factor productivity in 16 out of 20 manufacturing industries.

Tsionas (2003) also deduces a negative relationship between inflation and productivity for 15 European countries over the period 1960 to 1997. Tsionas's (2003) application of the Vector Error Correction Model (VECM) technique suggested a negative relationship between inflation and productivity growth for most of these European countries.

Furthermore, Christopoulos and Tsionas (2005) apply panel cointegration techniques to data from European countries over the period 1961 to 1999 and conclude a negative long run relationship between inflation and productivity growth in seven of the fifteen European countries under which empirical tests were conducted.

While these authors provide substantial evidence, at a high level of significance, to support the hypothesis that inflation and productivity do indeed share a negative relationship across different industries and countries in the long run, not all researchers arrive at similar clear-cut conclusions. Marcellino and Mizon (2000), who estimate the relationships between wages, prices, productivity, inflation and unemployment in Italy over the period 1970 through 1994 using a cointegrated vector autoregression model, find that inflation increases with excess productivity. Two observations must be noted here. First, according to Marcellino and Mizon (2000), inflation is thought of as being caused by excess productivity as opposed to other authors' findings on the subject. In this scenario, positive deviations of productivity from its trend are considered as a proxy for excess demand, which go further to increase prices since supply of goods and services usually needs time to respond to such demand pressures. Secondly, this analysis would suggest that excess productivity growth Granger-causes inflationary growth. This relationship by Marcellino and Mizon (2000) represents a Phillips curve interpretation.

2.2 Evidence of Relationship between Real Wages and Productivity

Economic research conducted on the relationship between real wages and productivity suggests that the level of real wages is a key, if not the main determinant, of the number of hours an individual is willing to work. The real wage is the wage that is adjusted to compensate for increases in inflationary growth and thus measures the true quantity of baskets of goods and services that an hour's worth of labour can purchase. For this reason, many economists and researchers posit a positive relationship between real wages and productivity since an increase in the real wage not only increases the quantity of goods and services a worker can now procure, but the opportunity cost of employment.

According to Wakeford (2004), real wages and productivity are hypothesised to share a positive relationship since higher real wages increase the opportunity cost of job loss thereby stimulating greater work effort to avoid redundancy. Wakeford (2004) further hypothesizes that higher real wages increase overall labour costs to firms causing firms to employ more capital to the detriment of labour thereby increasing the marginal productivity of each unit of labour. Thus in a sense, although an increase in real wages might cause firms to lay off more units of labour, the existing units of labour increase their efficiency to compensate for the laid off units of labour thereby increasing their marginal productivity. Marcellino and Mizon (2000) in their study on the relationships between wages, prices, productivity, inflation and unemployment in Italy over the period 1970 to 1994 also find strong evidence of a positive and more than proportional increase of real wages in response to increases in productivity.

Thus, recent research in economics postulates that indeed some dominant positive relationship exists between real wages and productivity. Furthermore, new developments in economic literature seem to shift focus to the rate of change in real wages and corresponding rates of change in productivity. Although such study per se is beyond the scope of this paper, the findings and conclusions of works carried out by economists and researchers concerning the differences in rates of change and responses of real wages to productivity across several industries and economies come into play later on in this paper's findings.

Recent study into the relationship between the rate and degree of response of real wages to productivity include Bosworth and Perry (1994), Sachdev (2007), Sharpe, Arsenault and Harrison (2008) and Rosenberg (2010). These authors, while acknowledging that increases in real wages should indeed accompany increases in productivity extend their study to address why real wages appear to increase at a slower rate than increases in productivity and the inherent implications and consequences that may arise from this phenomenon.

In what represents a deviation somewhat from the widely held norm of a positive relationship between real wages and productivity across industries and economies, is the backward bending supply curve of labour. Buchanan (1971) describes such a curve occurring when the supply of labour against wage rates becomes negatively sloped at higher wage rates as proportionately less labour is supplied. At high wage rates beyond a certain level, labour places more value on leisure as opposed to work. Consequently labour cuts back supply in favour of enjoying more leisure hours at a certain level of real wage. It is not exactly known with certainty whether real labour productivity diminishes at such high wages since labour reduces the amount of working. Some may argue that labour may achieve higher efficiency levels in the fewer hours it chooses to work. This paper does not delve further into this topic but merely wishes to bring to the attention of the reader the theory of the backward bending supply curve of labour and how it relates to the relationship between real wages and productivity.

2.3 Evidence of Relationship between Inflation, Real Wages and Productivity

Given the statistical and significant discovery of relationships between inflation, real wages and productivity, as well as the likely impacts within national economies and on a global scale, economic literature now concerns itself with a simultaneous study into the effects of all three variables on each other. Narayan and Smyth (2009) employ panel cointegration techniques to examine the relationships between inflation, real wages and productivity growth for the G7 countries over the period 1960 to 2004. Their results provide evidence of a positive statistical relationship between real wages and productivity growth but no statistically significant relationship between inflation and productivity growth. In addition, Strauss and Wohar (2004) conclude that long run inflationary growth Granger-causes productivity while bi-directional Granger causality exists between real wages and productivity across a sample of 459 American manufacturing industries over the period 1956 to 1996.

3. Data and Methodology

3.1 Empirical Concerns on Data

The author followed a related work by Kumar et al. (2009) in their data, proxy the rate of inflation by the growth of the consumer price index, real wages by the hourly compensation in the manufacturing sector and productivity by the output per hour in the manufacturing sector. This study uses annual time series covering from 1981 to 2012. Three widely macroeconomic indicators are employed: real wage, inflation and labour productivity. While this paper obtains its data from Central Bank of Nigeria (CBN) bulletin and World Bank index, it must be brought to the attention of the reader that this paper does not have at its disposal, the exact data employed by Kumar et al. (2009) to proxy real wages and productivity. Instead, this paper employs employees' compensation to proxy real wages and the GDP per employed person as a proxy for labour productivity. Inflation measures the general price level in the Nigerian economy.

Real GDP per capita (RGDPC), government expenditure (GOVEX) are included in the study to control for the influence of the Nigerian macro economy. These factors have identified among the most significant determinants of labour productivity (see Okoro, 2013) In study selection of data, the author recognizes the inherent potential likelihood of data constraint in the work of Kumar et al. (2009) and extent the current study by factoring other determinant of labour productivity. Table A provides additional information on all the variables.

Table A. List of variables

Variables	Definition	Sources
Prod	Labour productivity is the efficiency in the economy derived by dividing GDP at current price by total labour.	GDP at the current prices from CBN bulletin several issues and Total labour force from World bank indicators databse.
Wage	Real wage is measures the true quantity of baskets of goods and services that an hour's worth of labour can purchase. This is expected to have positive sign because higher real wages increase the opportunity cost of job loss thereby stimulating greater work effort to avoid redundancy. Wakeford (2004).	CBN bulletin several issues.
Infl	Inflation, consumer prices (annual %)	World development indicators database, world bank(online)
Rgdpc	It captures the economic growth of Nigeria from 1981-2014. In the spirit of okoro, (2013)GDP per capita (constant LCN)	World development indicators database, world bank(online)
Govex	This captures aggregate public expenditure in the form recurrent and capital expenditure(see Oliver ,2000)	CBN bulletin several issues.

Source: author's compilation.

3.2 Model Specification

Following the work of Kumar et al. (2009), Hondroyiannis and Papapetrou (1997) and Strauss and Wohar (2004), the study specify a production function relating productivity to real wages and inflation as below to examines three empirical models to determine the relationship between real, inflation and labour productivity in Nigeria over the sample.

$$prod = f(wage, infl) \quad \text{(Model 1)}$$

Controlling for the influence of rgdpc and government expenditure, the function as thus:

$$prod = f(wage, infl, rgdpc) \quad \text{(Model 2)}$$

$$prod = f(wage, infl, rgdpc, govex) \quad \text{(Model 3)}$$

All the variables have been explained in the above (table A).

The above production function can be re-written as to give the econometric model for this study as thus:

$$lnY_t = \alpha + \beta_1 lnW_t + \beta_2 lninfl_t + \varepsilon_t \quad (1)$$

$$lnY_t = \alpha + \beta_1 lnW_t + \beta_2 lninfl_t + \beta_3 lnrgdp_t + \varepsilon_t \quad (2)$$

$$lnY_t = \alpha + \beta_1 lnW_t + \beta_2 lninfl_t + \beta_3 lnrgdp_t + \beta_4 lngovex_t + \varepsilon_t \quad (3)$$

In the production function lnY_t is the natural log of productivity, lnW_t is the natural log of real wage, $lninfl_t$ is the natural log inflation, $lnrgdp_t$ is the natural log of real gross domestic product, $lngovex_t$ is the natural log of government expenditure, α is the intercept, β_1 to β_4 are the elasticities with respect to change to productivity.

3.3 Unit root Test

In time series analysis, before running the cointegration test the variables must be tested for stationarity. For this purpose, we use the conventional ADF tests, the Phillips– Perron test following Phillips and Perron (1988). The ARDL bounds test is based on the assumption that the variables are I(0) or I(1). Therefore, before applying this test, we determine the order of integration of all variables using unit root tests by testing for null hypothesis $H_o: \beta = 0$ (i.e β has a unit root), and the alternative hypothesis is $H_1: \beta < 0$. The objective is all variables should not be I(2) so as to avoid spurious results. In the presence of variables integrated of order two we cannot interpret the values of F statistics provided by Pesaran et al. (2001) or it will go boasted.

3.4 Cointegration Approach

In order to empirically analyse the long-run relationships and short-run relationship between real wage, inflation and production, this study apply the autoregressive distributed lag (ARDL) cointegration technique as a general vector autoregressive (VAR).

The ARDL cointegration approach was developed by Pesaran and Shin (1999) and Pesaran et al. (2001).This approach enjoys several advantages over the traditional cointegration technique documented by (Johansen and Juseline, 1990). Firstly, it requires small sample size. Two set of critical values are provided, low and upper value bounds for all classification of explanatory variables into pure I(1), purely I(0) or mutually cointegrated. Indeed, these critical values are generated for various sample sizes. However, Narayan (2005) argues that existing critical values of large sample sizes cannot be employed for small sample sizes. Secondly, Johensen's procedure require that the variables should be integrated of the same order, whereas ARDL approach does not require variable to be of the same order. Thirdly, ARDL approach provides unbiased long-run estimates with valid t'statistics if some of the model repressors are endogenous (Narayan 2005; Odhiambo, 2008).Fourthly, this approach provides a method of assessing the short run and long run effects of one variables on the other and as well separate both once an appropriate choice of the order of the ARDL model is made, (see Bentzen & Engslted, 2001). In this regard, Pesaran and Shin (1999) explain that AIC and SC perform well in small sample, but SC is relatively superior to AIC. The ARDL model is written as follow;

$$\Delta lnprod_t = \alpha_0 + \sum_{i=1}^{n} \beta_{1i} \Delta lnprod_{t-1} + \sum_{i=0}^{n} \beta_{2i} \Delta lnwage_{1_{t-1}} + \sum_{i=0}^{n} \beta_{3i} \Delta lninfl_{2_{t-1}} + \beta_4 lnprod_{t-1} + \beta_5 lnwage_{t-1} + \beta_6 lninfl_{t-1} + \varepsilon_t \quad (4)$$

$$\Delta lnprod_t = \alpha_0 + \sum_{i=1}^{n} \beta_{1i} \Delta lnprod_{t-1} + \sum_{i=0}^{n} \beta_{2i} \Delta lnwage_{1_{t-1}} + \sum_{i=0}^{n} \beta_{3i} \Delta lninfl_{2_{t-1}} + \sum_{i=0}^{n} \beta_{4i} \Delta lnrgdpc_{2_{t-1}} + \beta_5 lnprod_{t-1} + \beta_6 lnwage_{t-1} + \beta_7 lninfl_{t-1} + \beta_8 lnlnrgdpc_{t-1} + \varepsilon_t \quad (5)$$

$$\Delta lnprod_t = \alpha_0 + \sum_{i=1}^{n} \beta_{1i} \Delta lnprod_{t-1} + \sum_{i=0}^{n} \beta_{2i} \Delta lnwage_{1_{t-1}} + \sum_{i=0}^{n} \beta_{3i} \Delta lninfl_{2_{t-1}} + \sum_{i=0}^{n} \beta_{4i} \Delta lnrgdpc_{3_{t-1}} + \sum_{i=0}^{n} \beta_{5i} \Delta lngovex_{4_{t-1}} + \beta_5 lnprod_{t-1} + \beta_6 lnwage_{t-1} + \beta_7 lninfl_{t-1} + \beta_8 lnlnrgdpc_{t-1} + \beta_9 lnlnrgovex_{t-1} + \varepsilon_t \quad (6)$$

Where Δ is the difference operator while ε_t is white noise or error term. The bounds test is mainly based on the joint F-statistic whose asymptotic distribution is non-standard under the null hypothesis of no cointegration. The first step in the ARDL bounds approach is to estimate the four equations (4–6) by ordinary least squares (OLS). The estimation of the three equations tests for the existence of a long-run relationship among the variables by conducting an F-test for the joint significance of the coefficients of the lagged levels of the variables. The null hypothesis of no co-integration and the alternative hypothesis which are presented in (Table B) below as thus:

Table B.

null hypothesis of no co-integration	alternative hypothesis	Equation
$H_0: \beta_1 = \beta_2 = 0$	$H_1: \beta_1 \neq \beta_2 \neq 0$	4
$H_0: \beta_1 = \beta_2 = \beta_3 = 0$	$H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq 0$	5
$H_0: \beta_1 = \beta_2 = \beta_3 + \beta_4 = 0$	$H_1: h_1 \neq h_2 \neq h_3 \neq 0$	6

Source: author's design. Note. all the variables defined previously.

Two sets of critical values for a given significance level can be determined (Narayan 2005). The first level is calculated on the assumption that all variables included in the ARDL model are integrated of order zero, while the second one is calculated on the assumption that the variables are integrated of order one. The null hypothesis of no cointegration is rejected when the value of the test statistic exceeds the upper critical bounds value, while it is not rejected if the F-statistic is lower than the lower bounds value. Otherwise, the cointegration test is inconclusive. In the spirit of Odhiambo (2009) and Narayan and Smyth (2008), we obtain the short-run dynamic parameters by estimating an error correction model associated with the long-run estimates. The equation, where the null hypothesis of no cointegration is rejected, is estimated with an error-correction term (Narayan & Smyth, 2006; Morley, 2006). The vector error correction model is specified as follows:

$$\Delta lnprod_t = \alpha_0 + \sum_{i=1}^{n} \beta_{1i} \Delta lnprod_{t-1} + \sum_{i=0}^{n} \beta_{2i} \Delta lnwage_{1_{t-1}} + \sum_{i=0}^{n} \beta_{3i} \Delta lninfl_{2_{t-1}} + \lambda_1 ECM_{t-1} + \mu_{1t} \quad (7)$$

$$\Delta lnprod_t = \alpha_0 + \sum_{i=1}^{n} \beta_{1i} \Delta lnprod_{t-1} + \sum_{i=0}^{n} \beta_{2i} \Delta lnwage_{1_{t-1}} + \sum_{i=0}^{n} \beta_{3i} \Delta lninfl_{2_{t-1}} + \sum_{i=0}^{n} \beta_{4i} \Delta lnrgdpc_{2_{t-1}} + \lambda_2 ECM_{t-1} + \mu_{1t} \quad (8)$$

$$\Delta lnprod_t = \alpha_0 + \sum_{i=1}^{n} \beta_{1i} \Delta lnprod_{t-1} + \sum_{i=0}^{n} \beta_{2i} \Delta lnwage_{1_{t-1}} + \sum_{i=0}^{n} \beta_{3i} \Delta lninfl_{2_{t-1}} + \sum_{i=0}^{n} \beta_{4i} \Delta lnrgdpc_{3_{t-1}} + \sum_{i=0}^{n} \beta_{5i} \Delta lngovex_{4_{t-1}} + \lambda_3 ECM_{t-1} + \mu_{1t} \quad (9)$$

ECM_{t-1} is the error correction term obtained from the cointegration model. The error coefficients $(\lambda_1, \lambda_2 \text{ and } \lambda_3)$ indicate the rate at which the cointegration model corrects its previous period's disequilibrium or speed of adjustment to restore the long run equilibrium relationship. A negative and significant ECM_{t-1} coefficient implies that any short run movement between the dependant and explanatory variables will converge back to the long run relationship.

3.5 Stability and Diagnostic Test

To ensure the goodness of fit of the model, diagnostic and stability tests are conducted. Diagnostic tests examine the model for serial correlation, functional form, non-normality and heteroscedasticity. The stability test is conducted by employing the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ) suggested by Brown et al. (1975). The CUSUM and CUSUMSQ statistics are updated recursively and plotted against the break points. If the plots of the CUSUM and CUSUMSQ statistics stay within the critical bonds of a 5 percent level of significance, the null hypothesis of all coefficients in the given regression is stable and cannot be rejected.

4. Presentation of Empirical Results

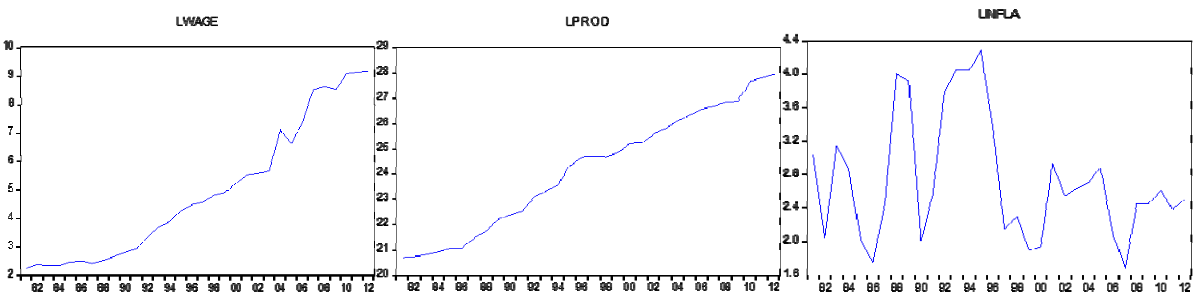

Figure 1. Trend of real wage, inflation rate and labour productivity

Source: author's computation.

Figure 1 shows the trend in real wage, inflation and labour productivity in Nigeria for the period 1981-2012. From the graph above, real wage had a slight change from 1981 to 1987. From 1988 to 2003. It maintained a consistent increase with a slight drop in 2004.It picks thereafter and drops sharply in 2006. This fluctuation continues up until 2012. These changes are accounted for due series of regime and structural changes. The same trend is observed in labour productivity especially in 1986, 1992, 1994 and 2010. Similar feature is observed in all the variables from 2007 to 2010 corresponding to the global financial crisis. Interestingly, inflation rate had a different look in the form of mean reverting. This is because the variable is always in stationary form.

Table 1. Descriptive statistics

	Mean	Median	Maximum	Minimum	Std dev	Skewness	Kurtosis	J-B	Prob
lnprod	24.183	24.689	27.942	20.701	2.359	-0.074	1.698	2.289	0.318
lnwage	4.939	4.536	9.168	2.248	2.397	0.544	1.933	3.091	0.213
lnfla	2.734	2.560	4.288	1.683	0.744	0.673	2.386	2.922	0.232
lnrgdpc	12.336	12.219	12.796	12.058	0.230	0.833	2.203	4.542	0.103
lngovex	5.553	5.940	8.458	2.266	2.125	-0.231	1.635	7.765	0.251

Source: author's computation.

Table 1 above provides the summary statistics, namely, sample means, maximums, minimums, medians, standard deviations, skewness, kurtosis and the Jarque-Bera tests with their p-values for the return series. Three variables real wage proxy by employee compensation, inflation and labour productivity and two control variables real GDP per capita and aggregate government expenditure over the period of 1981 to 2012. Whilst it is clear that all the statistics show the characteristics common with most financial data, there are a number of noticeable differences, especially between inflation, real GDP per capita and other variables. Firstly, some variables in likes of production and real GDP per capita are larger than their counterparts. More specifically, labour productivity has the largest average ₦24.183 with a minimum of 20.7 and a maximum of 27.9. The inflation rate recorded the least average around ₦2.7 with a minimum and maximum are 1.683 and 4.288 respectively. Between the control variables, real gdp per capita has the second highest average and aggregate government expenditure the third with average of 12.33 and 5.552 respectively. Of the key variables, real wage has the higher unconditional average of around ₦4.93 and its minimum fluctuates between 2.24 and 9.16 respectively.

Standard deviation measures the existence of risk or volatility among variables. It displays the rate at which each variable deviate from the mean. As evident from the Table 1 real wage recorded highest standard deviation of around 2.35, whilst inflation rate has the lowest of about 0.23 compared to the other variables. This could be because there have been a lot of political issues and in line with the theoretical underpinnings.

The skewness measures the asymmetric nature of the data and the probability distribution of a real-valued random variable about its mean. A normal distribution is symmetrical at point 0. If the value is greater than zero (>0) it is positive skewed, but if less than zero it negatively skewed (see Wooldridge, 2010). Labour productivity and aggregate government expenditure are negatively skewed with -0.07417 and -0.2308 except for the real wage, inflation rate and real gdp per capita that record 0.544, 0.673 and 0.832 respectively. All the variables under consideration have distributions with positive kurtosis in the form of platykurtic evidence from their values that are less than 3.

Lastly, the Jarque-Bera (JB) statistic tests whether the series are normally distributed. As can be seen from the Table 1, the JB indicates that the hypothesis of normality is not rejected for all series. This normality is also evident from the kurtosis and skewness.

4.1 Unit Root Tests

Table 2. Unit root test

	In Level I(0)		In Level I(1)		
Variable	ADF	PP	ADF	PP	Order of integration
Lnwage	0.812906	1.110131	-6.514949***	-6.427533***	1(1)
LnProd	0.183757	0.215544	-5.520008***	-5.552449***	1(1)
LnInfla	-3.093799***	-2.993743**	-6.128340***	-8.531979***	1(0)
LnGOVTEX	0.395525	0.102505	-4.127333***	-4.113733***	1(1)
LnRGDPC	-0.570381	-0.57553	-7.192434***'	-7.051534***	1(1)

Note: All the variables are in the natural log form. **level of significance at 5%. ***level significance at 1%. Source: author's computation.

All that data are transformed into the natural log form. To determine the order of integration of the variables, the ADF (augmented Dickey-Fuller) test complemented with the PP (Philips-Perron) test in which the null hypothesis is $H_0 - \beta - 0$ (i.e β has a unit root) and the alternative hypothesis is $H_1: \beta < 0$ are implemented. The result for both the level and differenced variables presented in table 2.

The stationarity tests were performed first in levels and then in first difference to establish the presence of unit roots and the order of integration in all the variables. The results of the ADF and PP stationarity tests for each variable show that both tests fail to reject the presence of unit root for real wage, labour productivity, aggregate government expenditure and real gdp per capita data series in level, indicating that these variables are non-stationary at levels. The first difference results show that these variables are stationary at 1% significance level (integrated of order one 1(1)). However, inflation rate recorded presence of stationarity at first level 1(0) at 1% level significant (ADF) and (PP) respectively. The different order of integration of the variables makes ARDL the preferred approach to this empirical study.

4.2 Result of Cointegration Test

The result of the cointegration test, based on the ARDL bound testing approach, are presented in Table 3.Cointegration is tested on model 1, model 2 and model 3 using labour productivity as dependant variable. The result show that the F-statistic is higher than the upper bound critical value from Narayan (2005) at the 1% level significance using restricted intercept and no trend in specification for the three models. Even though the author controls for the influence of real gdp per capita (rgdpc), the model 2 and 3 still show a cointegration. Based on the aforementioned results, the null hypothesis of no cointegration is rejected in the entire three models. This indeed implies that each of the variables under consideration, real wage, inflation and labour productivity are bound by a long run relationship in Nigeria.

Table 3. ARDL bounds cointegration test

Model	Dependent variables	F-statistic	Result
Model 1 ARDL (3,0,2)	Lnprod	6.5208***	Cointegration
Critical value bounds (model 1; k=2)	1%	5%	10%
I0 Bound	4.948	3.478	2.845
I1 Bound	6.028	4.335	3.623
Model 2 ARDL (2,0,1,0)	lnprod	6.3106***	Cointegration
Critical value bounds (model 1; k=3)	1%	5%	10%
I0 Bound	4.428	3.164	2.618
I1 Bound	5.816	4.194	3.532
Model 3 ARDL (1,0,1,0,0)	lnprod	11.632***	Cointegration
Critical value bounds (model 1; k=4)	1%	5%	10%
I0 Bound	4.093	2.947	2.460
I1 Bound	5.532	4.088	3.460

Notes: source of Asymptotic critical value bounds: Narayan (2005) Appendix: case II. Restricted intercepted and no trend. ***level of significance at 1%.

Table 4. Long run coefficients

	Model 1	Model 2	Model 3
variables	Lnprod	Lnprod	Lnprod
C	2.5013	76.194***	32.089*
	(0.0834)	(3.6934)	(2.1357)
Lnwage	1.8499	1.4676***	0.5281*
	(1.056)	(7.004)	(1.8641)
Lninfla	9.4083	1.2598	0.3919**
	(0.5679)	(0.124)	(2.132)
Lnrgdpc		-4.956***	-1.2065
		(-2.821)	(-0.968)
Lngovex			0.6565**
			(2.9865)

***level of significance at 1%. Source: author's computation from eview9.

Table 4 presents the long run coefficients of the three specifications/models estimated using ARDL approach. The specifications in table 4 are the same as the specifications described in table 3. The results for specification 1 gives the long run impact of inflation rate real wage rate captured by employees' compensation on labour productivity. All the dependant variables have no statistical significance on the labour productivity. Controlling for the influence of real gdp per capita on labour productivity in model 2, the study found that the coefficient of real wage is positive and statistically significant at 1% level. With the coefficient of 1.4676, a

1% increase in real wage will cause labour productivity to increase by 1.4676 in the long run. On the other hand, a 1% decrease in real wage will cause labour productivity to decrease by 1.4676 in the long run. This is in conformity with the findings of Wakeford (2004) who conceives a positive relationship with labour productivity.The coefficient of inflation (lninfl) is found to be positive and insignificant in explaining labour productivity. In addition, the control variable the real gdp per capita (rgdppc) is negative and statistically significant at 1%. With coefficient of -4.956, a 1% increase in real gdpc will cause the labour productivity to increase by -4.956 in the long run.

Model 3 captures the effect of inflation, wage rate with the control variables in the likes of real gdpc and government expenditure (govex) on the labour productivity in Nigeria over the study period. It is evident that real wage is positive and statistically significant at 10% level. A coefficient of 0.528 indicates that a 1% increase in (real wage) will cause the labour productivity to increase by 0.528 in the long-run while 1% fall in real wage will cause 0.528 fall in the labour productivity. Interestingly, inflation rate (lninfl) is found to be positive and significant. With a coefficient of 0.3919, a 1% increase in inflation will cause labour productivity to increase by 0.3919 in the long run. On the other hand, a 1% decrease in inflation will cause labour productivity to decrease by 0.3919 in the long run. A caution should be exercise while interpreting this result. The rgdp shows negative and insignificance. Whereas government expenditure is positive and statistically significance. This implies that with 0.6565 coefficient, 1% increase government expenditure will cause labour productivity to increase by 0.6565 in the long run vice versa.

Table 5. Short run error correction estimates

	Model 1	Model 2	Model 3
Variables	Δlnprod	Δlnprod	Δlnprod
Ecm(-1)	-0.03182***	-0.1546***	-0.4363***
	(-5.2054)	(-5.630)	(-6.3218)
Δlnwage	0.1299	0.2676**	0.2601**
	(0.1225)	(2.9124)	(2.994)
Δlninfla	0.1666***	0.1034**	0.0891*
	(3.7573)	(2.485)	(2.3957)
Δlninfla(-1)	-0.0702		
	(-1.3616)		
Δlnrgdpc		-0.7496	-0.6505
		(0.1675)	(-0.1946)
Δlngovex			0.1522
			(1.3576)
R^2	0.9956	0.9957	0.9962
Adj R^2	0.9942	0.9945	0.9953
D-W stat	2.1647	2.103	2.422
SCx^2	4.695	4.0692	3.856

	[0.1955]	[0.1307]	[0.1462]
Hetx^2	10.2086	8.6207	8.2237
	[0.1771]	[0.1961]	[0.2222]

Note: t-statistics in ( ) p-value in [ ]. *level of significance at 10%. **level of significance at 5%. ***level of significance at 1%. Source: author's computation from eview9.

Table 5 presents the coefficient of the error correction model for all the three specifications. The coefficient of ecm(-1) in each of the three specifications is negative and significant at 1% level. The coefficients suggest that over 3% of the short run disequilibrium is corrected in the long run equilibrium in each of the three specifications. The short run relationship of real wage, inflation and labour productivity is found to be different from the long run effect reported in table 4. The coefficient of real wage is positive and statistically significant in the models except model 1. The coefficients in model 2 and 3 show that a 1% increase in real wage will cause the labour productivity to increase by 0.2676 and 0.2601 respectively, in the short run. The specification 1 show that real wage is insignificant short run determinant of labour productivity in the absence of improved real gdp per capital and government expenditure over the period of study.

Furthermore, table 5 shows that inflation rate in each of the three models is positive and statistically significant. This implies show that a 1% increase in inflation will cause the labour productivity to increase by 0.1666, 0.1034 and 0.0891 respectively, in the short run. This is in line with as Tsionas (2003) posit a positive relationship between inflation and productivity but in contrast with recent studies that reveal that there is a negative relationship between inflation and productivity and concludes that an increase in inflation invariably leads to a decrease in productivity. Notable works of economists and researchers who posit a negative relationship between inflation and productivity are Clark (1982), Ram (1984), Buck and Fitzroy (1988), Saunders and Biswas (1990), Selody (1990) and Sbordone and Kuttner (1994). Surprisingly, real gdp and government expenditure are insignificant in the short run.

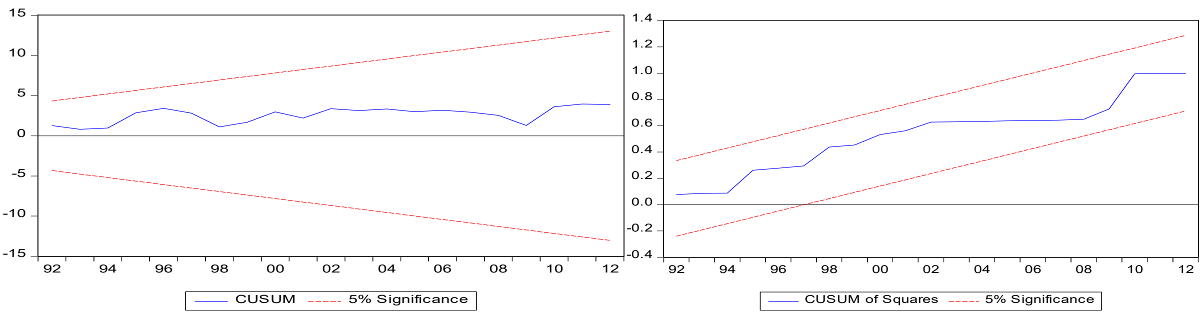

Figure 2. plot of CUSUM and CUSUMQ for coefficient stability of ECM for Model 1

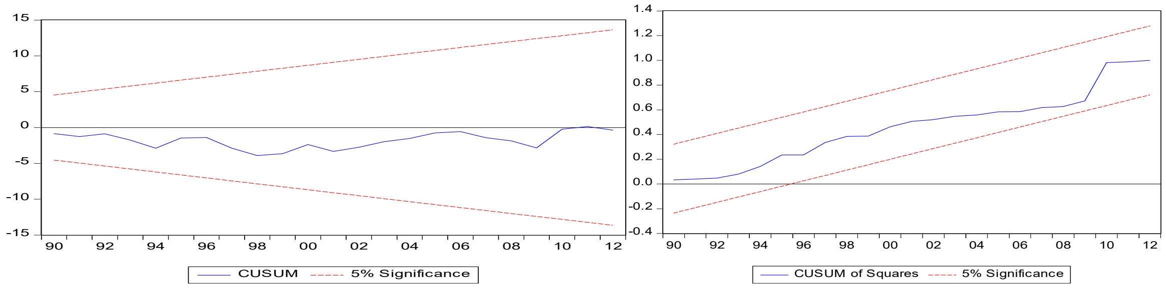

Figure 3. plot of CUSUM and CUSUMQ for coefficient stability of ECM for Model 2

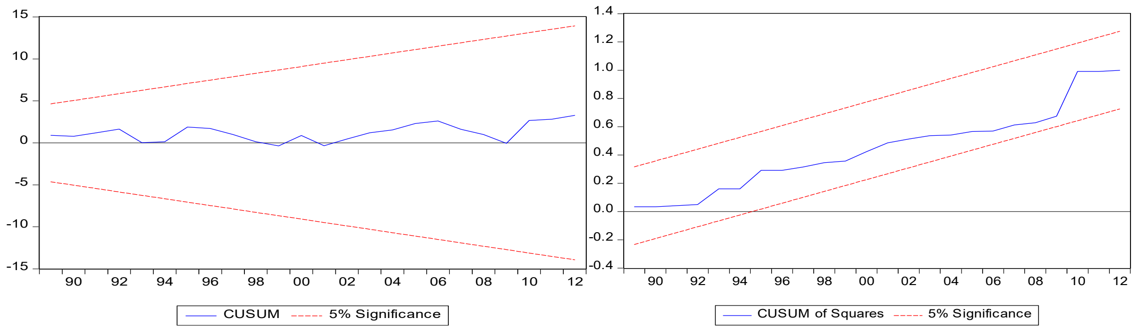

Figure 4. plot of CUSUM and CUSUMQ for coefficient stability of ECM for Model 3

3.5 Diagnostic and Stability Tests

From the diagnostic test result (see results in table 5), there is no evidence of serial correlation and heteroscedasticity in each of the ARDL models. The stability of the long-run coefficient is tested by the short-run dynamics. Once the ECM model given in table 5 has been estimated, the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMSQ) tests are applied to assess parameter stability (Pesaran and Pesaran, 1997). Figures 2-4 plot the results for CUSUM and CUSUMSQ tests. The results indicate the absence of any instability of the coefficients because the plot of the CUSUM and CUSUMSQ statistic fall inside the critical bands of the 5% confidence interval of parameter stability.

4. Conclusion and Policy Implementations

Controlling for the possible influence of real GDP per capita and government expenditure on labour productivity in Nigeria using the ARDL approach to cointegration analysis over the period of 1980 to 2012. This study examines the long run and short run relationship between real wage, inflation and labour productivity. The results suggest that the variables under consideration are not statistically significant in exerting influence on productivity when treated in isolation. This indeed is in contrast with the finding of Narayan and Smyth (2009) who employ panel cointegration techniques to examine the relationships between inflation, real wages and productivity growth for the G7 countries over the period 1960 to 2004. Their results provide evidence of a positive statistical relationship between real wages and productivity growth but no statistically significant relationship between inflation and productivity growth. A positive and significant long run relationship between real wage and labour productivity show that the former is a major driver of latter when the researcher includes real GDP per capital as a control variable. This coexists with a positive short run relationship thereby highlighting the dual effects of real wage on labour productivity in Nigeria. This finding is in line with Wakeford (2004), and Marcellino and Mizon (2000) among others who also find strong evidence of a positive and more than proportional increase of real wages in response to increases in productivity.

The positive significant long run and short run effect of inflation on labour productivity in Nigeria confirms the high dependency of labour productivity on inflation. The results suggest that an increase in inflation will exert increase with excess productivity. To maintain this level argument, inflation must be accompany with government expenditure. This is in conformity with finding of Marcellino and Mizon (2000), who estimate the relationships between wages, prices, productivity, inflation and unemployment in Italy over the period 1970 through 1994 using a cointegrated vector autoregression model, find that inflation increases with excess productivity. However, this study is in contrast with the notable findings of Selody (1982), Clark (1982) and Hondroyiannis and Papapetrou (1997) and Christopoulos and Tsionas (2005) who document that inflation influences the level of productivity growth by reducing the incentive and morale of labour to work, distorts the informational content contained within relative prices (which leads to inefficient investment plans), and finally shrinks the tax reductions for depreciation (which results in an increase in the rental price of capital).

This study provides empirical assessment of the relationship between real wage, inflation and labour productivity in Nigeria. From the level of interaction between this variables holds some policy implications for the Nigeria economy and co-researchers. Controlling the dependency of labour productivity on real wage. This might provide further productivity gains through government spending. Therefore, authorities aiming to enhance productivity should seek adjustments that do not create inflationary pressures from the labour market. Since the objective of government policy is to increase well-being, increasing real wages, which in turn raise living standards, a key determinant of well-being, can be an important policy objective. Therefore if the government do not see the benefit of labour productivity growth in the form of higher real wages, it is less likely that they would be willing to support policies that foster labour productivity growth.

References

Andrews, D. W. K. (1993). Tests for parameter instability and structural change with unknown change point. *Econometrica, 61*, 821-856.

Andrews, D. W. K., & Ploberger, W. (1994). Optimal tests when a nuisance parameter is present only under the alternative. *Econometrica*, *62*, 1383-1414.

Bardsen, G., Hurn, S., & Mchugh, Z. (2007). Modelling wages and prices in Australia. *The Economic Record*, *83*,143-158.

Bitros, C. C., & Panas, E. E. (2001). Is there an inflation productivity trade-off? Some evidence from the manufacturing sector in Greece. *Applied Economics*, *33*, 1961-1969.

Bosworth, B., & Perry, G. L. (1994). *Productivity and real wages: Is there a puzzle?* Brookings Papers on Economic Activity, Brookings Institution.

Buchanan, J. M. (1971). The Back-bending supply curve of labour: An example of doctrinal retrogression. *History of political Economy*, 383-390.

Buck, A. J., & Fitzroy, F. (1988). Inflation and productivity growth in the federal republic of Germany. *Journal of Post Keynesian Economics*, *10*, 428-444.

Bulman, T., & Simon, J. (2003). *Productivity and inflation*. Research Discussion Paper, Economic Research Department, Reserve Bank of Australia.

Christopolous, D. K., & Tsionas, E. G. (2005). Productivity growth and inflation in Europe: Evidence from panel cointegration tests. *Empirical Economics*, *30*, 137-150.

Chow, C. G. (1960). Tests of equality between sets of coefficients in two linear regressions. *Econometrica, 28*, 591-605.

Clark, K. P. (1982). Inflation and the productivity decline. *American Economic Review, Papers and Proceedings*, *72*, 149-154.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 427-431.

Engle, R. F., & Granger, C. W. J. (1987). Cointegration and error correction representation, estimation and Testing. *Econometrica, 55*, 251-276.

Bentzen, J., & Engsted, T. (2001). A revival of the ARDL model in estimating energy demand relationship (Cointegration: Bounds Testing Approach). *Energy Finance*, *26*, 45-55.

Georgellis, Y. (1994). The oil price shocks and the unit root hypothesis: the UK experience. *Applied Economics, 26*(8), 827-830.

Gordon, R. J. (1987). Productivity, wages, and prices inside and outside of manufacturing in the US, Japan and Europe. *European Economic Review*, *31*, 685-739.

Gregory, A. W., & Hansen, B. E. (1996). Residual-based tests for cointegration in models with regime shifts. *Journal of Econometrics, 70*, 99-126.

Hondroyiannis, G., & Papapetrou, E. (1997). Seasonality cointegration and the inflation, productivity and wage growth relationship in Greece. *Social Science Journal*, *34*, 235-247.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, *12*, 231-254.

Johansen, S. (1991) Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica*, *59*, 1551-1580.

Kumar, S., Webber, D. J., & Perry, G. (2009). Real wages, inflation and labour productivity in Australia. Retrieved from http://mpra.ub.uni-muenchen.de/19293/MPRA

Marcellino, M., & Mizon, G. E. (2000). *Wages, prices, productivity, inflation and unemployment in Italy 1970-1994* (2nd version). Econometric Society World Congress

McNown, R., & Seip, K. L. (2010). Periods and structural breaks in US economic history 1959-2007. *Journal of Policy Modeling, 33*(2), 169-182.

Narayan, P. K., & Smyth, R. (2009). The effect of inflation and real wages on productivity: New evidence from a panel of G7 countries. *Applied Econom*ics, 41, 1285-1291.

Narayan, P. K. (2005). The saving and investment nexus for China: evidence from cointegration tests. *Applied Economics, 37*(17), 1979-1990.

Odhiambo, N. M. (2009). Energy consumption and economic growth in Tanzania: An ARDL bounds testing approach. *Energy Policy*, *37*(2) 617-622.

Phillips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression. *Biomerika Trust, 75*(2), 335-346.

Ram, R. (1984). Causal ordering across inflation and productivity growth in the post-war United States. *Review of Economics and Statistics, 66*, 472-477.

Rosenberg, B. (2010). Real wages and productivity in New Zealand. Papers for Presentation at Fourteenth Labour Employment and Work Conference. Retrieved from http://www.victoria.ac.nz/vms/researchcentres/LEW_Published_Papers.aspx/

Sachdev, N. (2007). *An examination of the wage productivity gap*. Department of Economics: Standford University.

Saunders, P., & Biswas, B. (1990). An empirical note on the relationship between inflation and productivity in the United Kingdom. *British Review of Economic Issues, 12*(28), 67-77.

Sbordone, A., & Kuttner, K. (1994). Does inflation reduce productivity. *Economic Perspectives*, (6), 2-14.

Selody, J. (1990). *The goal of price stability: A review of the issues*. Bank of Canada Technical Report 54.

Sharpe, A., Arsenault, J-F., & Harrison, P. (2008). *The relationship between labour productivity and real wage growth in Canada and OECD countries*. CSLS Research Report No. 2008-8

Tsionas, E. G. (2003a). Inflation and productivity in Europe: an empirical investigation. *Empirica*, *30*, 39-62.

Tsionas, E. G. (2003b). Inflation and productivity: empirical evidence from Europe. *Review of International Economics*, *11*, 114-129.

Wakeford, J. (2004). The productivity-wage relationship in South Africa: An empirical investigation. *Development South Africa*, *21*, 109-132.